OK TO ENTER M.B. 4/4/05

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application. With this amendment and as reflected in this listing of claims, original claims 1-18 which now stand rejected, have been canceled. New claims 19-23 are now presented:

Listing of Claims:

1 1. (Canceled).

1 2. (Canceled)

1 3. (Canceled).

1 4. (Canceled).

1 5. (Canceled).

1 6. (Canceled).

1 7. (Canceled).

1 8. (Canceled).

1 9. (Canceled).

1 10. (Canceled).

11. (Canceled).

12. (Canceled).

13. (Canceled).

14. (Canceled).

15. (Canceled).

16. (Canceled).

17. (Canceled).

18. (Canceled).

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~~19~~ 1. (New) A computer-implemented method for recognizing compound events depicted in video sequences, said compound events being determined from occurrences of primitive events depicted in the video sequences, wherein the compound events are defined as a combination of the primitive events, the method comprising the steps of:

(a) defining primitive event types, said primitive event types including: x = y; Supported(x); RigidlyAttached(x, y); Supports(x, y); Contacts(x, y); and Attached(x, y);

(b) defining combinations of the primitive event types as a compound event type, said compound event type being one of: PickUp(x,y,z); PutDown(x,y,z); Stack(w,x,y,z); Unstack(w,x,y,z); Move(w,x,y,z); Assemble(w,x,y,z); and Disassemble(w,x,y,z);

(c) inputting, a series of video sequences, said video sequences depicting primitive event occurrences, such occurrences being specified as a set of temporal intervals over which a given primitive event type is true; and

(d) determining, the compound event occurrences, such occurrences being specified as the set of temporal intervals over which the compound event type is true, wherein the sets of temporal intervals in steps (c) and (d) are specified as smaller sets of spanning intervals, each spanning interval representing a set of all sub-intervals over which the primitive event type holds and wherein the spanning intervals take the form ${}_\alpha[{}_\gamma[i,j]_\delta, {}_\epsilon[k,l]_\zeta]_\beta$, where $\alpha,\beta,\gamma,\delta,\epsilon$, and ζ are Boolean values, i,j,k, and l are real numbers, ${}_\alpha[{}_\gamma[i,j]_\delta, {}_\epsilon[k,l]_\zeta]_\beta$ represents the set of all intervals ${}_\alpha[p,q]_\beta$ where $i \leq_\gamma p \leq_\delta j$ and $k \leq_\epsilon q \leq_\zeta l$, ${}_\alpha[p,q]_\beta$ represents the set of all points r, where $p \leq_\alpha r \leq_\beta q$, and $x \leq_\theta y$ means $x \leq y$ when θ is true and $x < y$ when θ is false.

2 ~~20~~. (New) The method according to claim 1 ~~19~~, wherein the compound event type in step (b) is specified as an expression in temporal logic. am. d. 4/5/05

3 ~~21~~. (New) The method according to claim 2 ~~20~~, wherein the temporal logic expressions are constructed using the logical connectives $\forall, \exists, \vee, \wedge_R, \Diamond_R$, and $\neg$, where R ranges over sets of relations between one-dimensional intervals.

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4 ~~22~~. (New) The method according to claim 3 ~~21~~ ~~3~~, wherein the relations are =, <, >, m, mi, o, oi, s, si, f, fi, d, and di.

5 ~~23~~. (New) The method according to claim 4 ~~22~~, wherein the compound event occurrences are computed through the use of the following set of equations:

$$\varepsilon(M, p(c_1,\ldots,c_n)) \triangleq \{\mathbf{i} \mid p(c_1,\ldots,c_n)@\mathbf{i} \in M\}$$

$$\varepsilon(M, \Phi \vee \Psi) \triangleq \varepsilon(M,\Phi) \cup \varepsilon(M,\Psi)$$

$$\varepsilon(M, \forall x \Phi) \triangleq \bigcup_{\mathbf{i}_1 \in \varepsilon(M, \Phi[x:=c_1])} \cdots \bigcup_{\mathbf{i}_n \in \varepsilon(M, \Phi[x:=c_n])} \mathbf{i}_1 \cap \cdots \cap \mathbf{i}_n$$

$$\text{where } C(M) = \{c_1, \ldots, c_n\}$$

$$\varepsilon(M, \exists x \Phi) \triangleq \bigcup_{c \in C(M)} \varepsilon(M, \Phi[x := c])$$

$$\varepsilon(M, \neg\Phi) \triangleq \bigcup_{\mathbf{i}'_1 \in \neg \mathbf{i}_1} \cdots \bigcup_{\mathbf{i}'_n \in \neg \mathbf{i}_n} \mathbf{i}'_1 \cap \cdots \cap \mathbf{i}'_n$$

$$\text{where } \varepsilon(M, \Phi) = \{\mathbf{i}_1, \ldots, \mathbf{i}_n\}$$

$$\varepsilon(M, \Phi \wedge_R \Psi) \triangleq \bigcup_{\mathbf{i} \in \varepsilon(M,\Phi)} \bigcup_{\mathbf{j} \in \varepsilon(M,\Psi)} \bigcup_{r \in R} \mathcal{J}(\mathbf{i}, r, \mathbf{j})$$

$$\varepsilon(M, \Diamond_R \Phi) \triangleq \bigcup_{\mathbf{i} \in \varepsilon(M,\Phi)} \bigcup_{r \in R} \mathfrak{D}(r, \mathbf{i})$$

where,

$$\langle {}_{\alpha}[{}_{\gamma}[i,j]_{\delta},{}_{\epsilon}[k,l]_{\zeta}]_{\beta} \rangle \triangleq \begin{cases} \left\{ {}_{\alpha}[{}_{\gamma'}[i,j']_{\delta'},{}_{\epsilon'}[k',l]_{\zeta'}]_{\beta} \right\} & \\ \text{where } \; j' = \min(j,l) & \\ \quad k' = \max(k,i) & \\ \quad \gamma' = \gamma \wedge i \neq -\infty & \\ \quad \delta' = \delta \wedge \min(j,l) \neq \infty \wedge (j < l \vee \zeta \wedge \alpha \wedge \beta) & \\ \quad \epsilon' = \epsilon \wedge \max(k,i) \neq -\infty \wedge (k > i \vee \gamma \wedge \beta \wedge \alpha) & \\ \quad \zeta' = \zeta \wedge l \neq \infty & \\ \text{when } \; i \leq j' \wedge k' \leq l \wedge & \\ \quad [i = j' \to (\gamma' \wedge \delta')] \wedge [k' = l \to (\epsilon' \wedge \zeta')] \wedge & \\ \quad [i = l \to (\alpha \wedge \beta)] \wedge & \\ \quad i \neq \infty \wedge j' \neq -\infty \wedge k' \neq \infty \wedge l \neq -\infty & \\ \{\} \quad \text{otherwise} & \end{cases}$$

$${}_{\alpha_1}[{}_{\gamma_1}[i_1,j_1]_{\delta_1},{}_{\epsilon_1}[k_1,l_1]_{\zeta_1}]_{\beta_1} \cap {}_{\alpha_2}[{}_{\gamma_2}[i_2,j_2]_{\delta_2},{}_{\epsilon_2}[k_2,l_2]_{\zeta_2}]_{\beta_2} \triangleq$$

$$\langle {}_{\alpha_1}[{}_{\gamma}[\max(i_1,i_2),\min(j_1,j_2)]_{\delta},{}_{\epsilon}[\max(k_1,k_2),\min(l_1,l_2)]_{\zeta}]_{\beta_1} \rangle$$

$$\text{where } \gamma = \begin{cases} \gamma_1 & i_1 > i_2 \\ \gamma_1 \wedge \gamma_2 & i_1 = i_2 \\ \gamma_2 & i_1 < i_2 \end{cases}$$

$$\delta = \begin{cases} \delta_1 & j_1 < j_2 \\ \delta_1 \wedge \delta_2 & j_1 = j_2 \\ \delta_2 & j_1 > j_2 \end{cases}$$

$$\epsilon = \begin{cases} \epsilon_1 & k_1 > k_2 \\ \epsilon_1 \wedge \epsilon_2 & k_1 = k_2 \\ \epsilon_2 & k_1 < k_2 \end{cases}$$

$$\zeta = \begin{cases} \zeta_1 & l_1 < l_2 \\ \zeta_1 \wedge \zeta_2 & l_1 = l_2 \\ \zeta_2 & l_1 > l_2 \end{cases}$$

when $\alpha_1 = \alpha_2 \wedge \beta_1 = \beta_2$

{} otherwise

$$\neg_{\alpha}[{}_{\gamma}[i,j]_{\delta}, {}_{\epsilon}[k,l]_{\zeta}]_{\beta} \triangleq \begin{pmatrix} \langle {}_{\alpha}[{}_{\mathrm{T}}[-\infty,\infty]_{\mathrm{T}}, {}_{\mathrm{T}}[-\infty,k]_{\neg\epsilon}]_{\beta} \rangle \cup \\ \langle {}_{\alpha}[{}_{\mathrm{T}}[-\infty,\infty]_{\mathrm{T}}, {}_{\neg\zeta}[l,\infty]_{\mathrm{T}}]_{\beta} \rangle \cup \\ \langle {}_{\alpha}[{}_{\mathrm{T}}[-\infty,i]_{\neg\gamma}, {}_{\mathrm{T}}[-\infty,\infty]_{\mathrm{T}}]_{\beta} \rangle \cup \\ \langle {}_{\alpha}[{}_{\neg\delta}[j,\infty]_{\mathrm{T}}, {}_{\mathrm{T}}[-\infty,\infty]_{\mathrm{T}}]_{\beta} \rangle \cup \\ \langle {}_{\neg\alpha}[{}_{\mathrm{T}}[-\infty,\infty]_{\mathrm{T}}, {}_{\mathrm{T}}[-\infty,\infty]_{\mathrm{T}}]_{\beta} \rangle \cup \\ \langle {}_{\alpha}[{}_{\mathrm{T}}[-\infty,\infty]_{\mathrm{T}}, {}_{\mathrm{T}}[-\infty,\infty]_{\mathrm{T}}]_{\neg\beta} \rangle \cup \\ \langle {}_{\neg\alpha}[{}_{\mathrm{T}}[-\infty,\infty]_{\mathrm{T}}, {}_{\mathrm{T}}[-\infty,\infty]_{\mathrm{T}}]_{\neg\beta} \rangle \end{pmatrix}$$

$$\mathrm{Span}({}_{\alpha_1}[{}_{\gamma_1}[i_1,j_1]_{\delta_1}, {}_{\epsilon_1}[k_1,l_1]_{\zeta_1}]_{\beta_1}, {}_{\alpha_2}[{}_{\gamma_2}[i_2,j_2]_{\delta_2}, {}_{\epsilon_2}[k_2,l_2]_{\zeta_2}]_{\beta_2}) \triangleq$$

$$\begin{pmatrix} \langle {}_{\alpha_1}[{}_{\gamma_1}[i_1,j]_{\delta}, {}_{\epsilon}[k,l_1]_{\zeta_1}]_{\beta_1} \rangle \cup \\ \langle {}_{\alpha_1}[{}_{\gamma_1}[i_1,j]_{\delta}, {}_{\epsilon}[k,l_2]_{\zeta_2}]_{\beta_2} \rangle \cup \\ \langle {}_{\alpha_2}[{}_{\gamma_2}[i_2,j]_{\delta}, {}_{\epsilon}[k,l_1]_{\zeta_1}]_{\beta_1} \rangle \cup \\ \langle {}_{\alpha_2}[{}_{\gamma_2}[i_2,j]_{\delta}, {}_{\epsilon}[k,l_2]_{\zeta_2}]_{\beta_2} \rangle \end{pmatrix}$$

where $j = \min(j_1, j_2)$

$k = \max(k_1, k_2)$

$\delta = [(\delta_1 \wedge j_1 \le j_2) \vee (\delta_2 \wedge j_1 \ge j_2)]$

$\epsilon = [(\epsilon_1 \wedge k_1 \ge k_2) \vee (\epsilon_2 \wedge k_1 \le k_2)]$

$$\mathfrak{D}(=,\mathbf{i}) \triangleq \{\mathbf{i}\}$$

$$\mathfrak{D}(<, {}_{\alpha_1}[{}_{\gamma_1}[i_1, j_1]_{\delta_1}, {}_{\epsilon_1}[k_1, l_1]_{\zeta_1}]_{\beta_1}) \triangleq \bigcup_{\alpha_2, \beta_2 \in \{T,F\}} \langle {}_{\alpha_2}[{}_{\neg\beta_1 \wedge \neg\alpha_2 \wedge \epsilon_1}[k_1, \infty]_T, {}_T[-\infty, \infty]_T]_{\beta_2} \rangle$$

$$\mathfrak{D}(>, {}_{\alpha_1}[{}_{\gamma_1}[i_1, j_1]_{\delta_1}, {}_{\epsilon_1}[k_1, l_1]_{\zeta_1}]_{\beta_1}) \triangleq \bigcup_{\alpha_2, \beta_2 \in \{T,F\}} \langle {}_{\alpha_2}[{}_T[-\infty, \infty]_T, {}_T[-\infty, j_1]_{\neg\alpha_1 \wedge \neg\beta_2 \wedge \delta_1}]_{\beta_2} \rangle$$

$$\mathfrak{D}(\mathrm{m}, {}_{\alpha_1}[{}_{\gamma_1}[i_1, j_1]_{\delta_1}, {}_{\epsilon_1}[k_1, l_1]_{\zeta_1}]_{\beta_1}) \triangleq \bigcup_{\beta_2 \in \{T,F\}} \langle {}_{\neg\beta_1}[{}_{\epsilon_1}[k_1, l_1]_{\zeta_1}, {}_T[-\infty, \infty]_T]_{\beta_2} \rangle$$

$$\mathfrak{D}(\mathrm{mi}, {}_{\alpha_1}[{}_{\gamma_1}[i_1, j_1]_{\delta_1}, {}_{\epsilon_1}[k_1, l_1]_{\zeta_1}]_{\beta_1}) \triangleq \bigcup_{\alpha_2 \in \{T,F\}} \langle {}_{\alpha_2}[{}_T[-\infty, \infty]_T, {}_{\gamma_1}[i_1, j_1]_{\delta_1}]_{\neg\alpha_1} \rangle$$

$$\mathfrak{D}(\mathrm{o}, {}_{\alpha_1}[{}_{\gamma_1}[i_1, j_1]_{\delta_1}, {}_{\epsilon_1}[k_1, l_1]_{\zeta_1}]_{\beta_1}) \triangleq \bigcup_{\alpha_2, \beta_2 \in \{T,F\}} \langle {}_{\alpha_2}[{}_{\alpha_1 \wedge \neg\alpha_2 \wedge \gamma_1}[i_1, l_1]_{\beta_1 \wedge \alpha_2 \wedge \zeta_1}, {}_{\neg\beta_1 \wedge \beta_2 \wedge \epsilon_1}[k_1, \infty]_T]_{\beta_2} \rangle$$

$$\mathfrak{D}(\mathrm{oi}, {}_{\alpha_1}[{}_{\gamma_1}[i_1, j_1]_{\delta_1}, {}_{\epsilon_1}[k_1, l_1]_{\zeta_1}]_{\beta_1}) \triangleq \bigcup_{\alpha_2, \beta_2 \in \{T,F\}} \langle {}_{\alpha_2}[{}_T[-\infty, j_1]_{\neg\alpha_1 \wedge \alpha_2 \wedge \delta_1}, {}_{\alpha_1 \wedge \beta_2 \wedge \gamma_1}[i_1, l_1]_{\beta_1 \wedge \neg\beta_2 \wedge \zeta_1}]_{\beta_2} \rangle$$

$$\mathfrak{D}(\mathrm{s}, {}_{\alpha_1}[{}_{\gamma_1}[i_1, j_1]_{\delta_1}, {}_{\epsilon_1}[k_1, l_1]_{\zeta_1}]_{\beta_1}) \triangleq \bigcup_{\beta_2 \in \{T,F\}} \langle {}_{\alpha_1}[{}_{\gamma_1}[i_1, j_1]_{\delta_1}, {}_{\neg\beta_1 \wedge \beta_2 \wedge \epsilon_1}[k_1, \infty]_T]_{\beta_2} \rangle$$

$$\mathfrak{D}(\mathrm{si}, {}_{\alpha_1}[{}_{\gamma_1}[i_1, j_1]_{\delta_1}, {}_{\epsilon_1}[k_1, l_1]_{\zeta_1}]_{\beta_1}) \triangleq \bigcup_{\beta_2 \in \{T,F\}} \langle {}_{\alpha_1}[{}_{\gamma_1}[i_1, j_1]_{\delta_1}, {}_T[-\infty, l_1]_{\beta_1 \wedge \neg\beta_2 \wedge \zeta_1}]_{\beta_2} \rangle$$

$$\mathfrak{D}(\mathrm{f}, {}_{\alpha_1}[{}_{\gamma_1}[i_1, j_1]_{\delta_1}, {}_{\epsilon_1}[k_1, l_1]_{\zeta_1}]_{\beta_1}) \triangleq \bigcup_{\alpha_2 \in \{T,F\}} \langle {}_{\alpha_2}[{}_T[-\infty, j_1]_{\neg\alpha_1 \wedge \alpha_2 \wedge \delta_1}, {}_{\epsilon_1}[k_1, l_1]_{\zeta_1}]_{\beta_1} \rangle$$

$$\mathfrak{D}(\mathrm{fi}, {}_{\alpha_1}[{}_{\gamma_1}[i_1, j_1]_{\delta_1}, {}_{\epsilon_1}[k_1, l_1]_{\zeta_1}]_{\beta_1}) \triangleq \bigcup_{\alpha_2 \in \{T,F\}} \langle {}_{\alpha_2}[{}_{\alpha_1 \wedge \neg\alpha_2 \wedge \gamma_1}[i_1, \infty]_T, {}_{\epsilon_1}[k_1, l_1]_{\zeta_1}]_{\beta_1} \rangle$$

$$\mathfrak{D}(\mathrm{d}, {}_{\alpha_1}[{}_{\gamma_1}[i_1, j_1]_{\delta_1}, {}_{\epsilon_1}[k_1, l_1]_{\zeta_1}]_{\beta_1}) \triangleq \bigcup_{\alpha_2, \beta_2 \in \{T,F\}} \langle {}_{\alpha_2}[{}_T[-\infty, j_1]_{\neg\alpha_1 \wedge \alpha_2 \wedge \delta_1}, {}_{\neg\beta_1 \wedge \beta_2 \wedge \epsilon_1}[k_1, \infty]_T]_{\beta_2} \rangle$$

$$\mathfrak{D}(\mathrm{di}, {}_{\alpha_1}[{}_{\gamma_1}[i_1, j_1]_{\delta_1}, {}_{\epsilon_1}[k_1, l_1]_{\zeta_1}]_{\beta_1}) \triangleq \bigcup_{\alpha_2, \beta_2 \in \{T,F\}} \langle {}_{\alpha_2}[{}_{\alpha_1 \wedge \neg\alpha_2 \wedge \gamma_1}[i_1, \infty]_T, {}_T[-\infty, l_1]_{\beta_1 \wedge \neg\beta_2 \wedge \zeta_1}]_{\beta_2} \rangle$$

and,

$$\mathrm{I}(\mathrm{i}, r, \mathrm{j}) \triangleq \bigcup_{\mathrm{i}' \in \mathfrak{D}(r^{-1}, \mathrm{j})} \bigcup_{\mathrm{i}'' \in \mathrm{i}' \cap \mathrm{i}} \bigcup_{\mathrm{j}' \in \mathfrak{D}(r, \mathrm{i})} \bigcup_{\mathrm{j}'' \in \mathrm{j}' \cap \mathrm{j}} \mathrm{Span}(\mathrm{i}'', \mathrm{j}'').$$